

pH and pKa calculations

$$\text{pH} = -\log [\text{H}_3\text{O}^+]$$

Calculate the pH of 10mL of 0.015M HNO_3 if 20mL of water is added to it.

The concentration of diluted HNO_3 is $1/3^{\text{rd}}$ of 0.015 = $0.015/3 = 5 \times 10^{-3}$

$$\text{pH} = -\log [5 \times 10^{-3}] = 2.30$$

$$K_w = 1 \times 10^{-14} = [\text{H}_3\text{O}^+] [\text{OH}^-]$$

Calculate $[\text{OH}^-]$ of the diluted HNO_3 solution

$[\text{H}_3\text{O}^+]$ is the concentration in molL^{-1} of the strong acid

$$[\text{OH}^-] = \frac{1 \times 10^{-14}}{5 \times 10^{-3}} = 2.0 \times 10^{-12}$$

$$K_a = \frac{[\text{H}_3\text{O}^+] [\text{A}^-]}{[\text{HA}]}$$

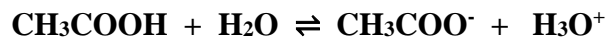
$$\text{p}K_a = -\log K_a$$

Calculate the pH of 20mL of 0.05M ethanoic acid if 20mL of water is added to it.

$$K_a(\text{CH}_3\text{COOH}) = 1.78 \times 10^{-5}$$

K_a value describes the extent that the acid will react with water. CH_3COOH is a weak acid so the K_a value is low, indicating that it is only slightly reactive with water so the K_a value must be used in the calculation

The concentration of diluted ethanoic acid is $1/2$ of 0.05 = $0.05/2 = 0.025 \text{molL}^{-1}$



$$K_a = \frac{[\text{CH}_3\text{COO}^-] [\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]}$$

$$1.78 \times 10^{-5} = \frac{x \cdot x}{0.025}$$

$$\sqrt{(1.78 \times 10^{-5}) (0.025)} = x$$

$$6.67 \times 10^{-4} = x \text{ (this is the concentration of } \text{H}_3\text{O}^+)$$

$$\text{pH} = -\log (6.67 \times 10^{-4})$$

$$\text{pH} = 3.18$$

$$K_b = \frac{[\text{H}_3\text{O}^+] [\text{A}^-]}{[\text{HA}]}$$

$$K_b = \frac{K_w}{K_a}$$

Calculate the pH of a 0.55M solution of ammonia

$$K_a(\text{NH}_4^+) = 5.75 \times 10^{-10}$$

$$K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{5.75 \times 10^{-10}}$$



$$K_b = \frac{[\text{NH}_4^+] [\text{OH}^-]}{[\text{NH}_3]}$$

$$1.74 \times 10^{-5} = \frac{x \cdot x}{0.55}$$

$$\sqrt{(1.74 \times 10^{-5}) (0.55)} = x$$

$$3.09 \times 10^{-3} = x \text{ (this is the concentration of } \text{OH}^-)$$

$$[\text{H}_3\text{O}^+] = \frac{1 \times 10^{-14}}{3.09 \times 10^{-3}}$$

$$[\text{H}_3\text{O}^+] = 3.24 \times 10^{-12}$$

$$\text{pH} = -\log 3.24 \times 10^{-12} = 11.5$$

